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Forthcoming Events.

MAY 10.

Institute of Marine Engineers:—Ordinary meeting in London. "Some Metals and Methods of Use in Marine Engineering," Paper by H. J. Young, F.I.C.

MAY 11.

Institute of Metals:—Annual May Lecture in London. Paper by Sir Henry A. Miers, F.R.S., on "The Growth of Crystals in Supersaturated Liquids."

Institute of British Foundrymen.

MAY 7.

Lancashire Branch:—Ordinary meeting at Manchester. "Some Aspects of Foundry Work," Paper by E. Longden.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Power in the Foundry.

Some facts of great interest to founders are brought out in a Paper recently given in Australia which does not appear to have attracted the attention it deserves in this country. The Paper aims at showing the relationship between power cost, power consumption, and the amount of wealth produced. It is estimated from available statistics that in 1833 the wealth per head in this country was £150, this figure rising in a straight line to £320 per head in 1914. The figure for the United States rises from £60 in 1850 to £240 in 1900, this portion of the line again being straight, but below the British line and gradually approaching it. In 1900 the American line bends sharply upwards, crossing the British line in 1906, when the figure for both countries is £300 per head. The American line, however, continues its upward course, and in 1922 reaches no less a figure than £600 per head.

The striking feature brought out is that the American growth of wealth with time curve is practically parallel to the curve of the power available per man in the manufacturing industries. The wealth curve is naturally behind the power curve in time, the difference being fifteen years. May it not be that the remarkable wealth increase in the States is due to the extent to which operatives have been provided with mechanical power? It appears also that wages increase continuously and steadily as power is increased, and the value added to the raw material by the process of manufacture increases at a greater rate than either wages or power. Furthermore, in grouping 75 Australian industries in seven groups according to power installed per man, from Group A using less than ¼ h.p. per man to Group G using more than 4½ h.p. per man, it is shown that the value added in manufacture is greatest in Group G. There is one significant exception to this, the iron and steel industry, which, using less than 2 h.p. per man, adds less to the raw material by manufacture than any other industry. The author, Mr. G. A. Julius, is able to explain the special position of the Australian iron and steel industry more or less satisfactorily, and he draws the interesting conclusion that the production of wealth can be fostered and wages increased by the freer use of power—which to-day invariably means electrical power—and, of course, of the machines in which power is employed.

It would be interesting to have such an analysis conducted for British industries, and when the figures for the recent Census of Production are completed doubtless an attempt can be made.

It would appear that the use of machinery is the precursor of a greater increase in productivity than that contemplated by the manufacturer when the machinery is installed. The causes of this are obscure, but a machine-equipped industry possesses a higher degree of adaptability in meeting unexpected demands than one relying on manual labour. During the war the training of labour for certain skilled operations was a much bigger problem than the production of machines for increasing output.

These considerations should prove of much interest to founders, who so often find that the immediate advantages to be gained by displacing manual labour do not represent sufficient saving over the cost of capital outlay and depreciation. These considerations, of course, apply to all types of machinery used in the foundry, for, if the examination quoted is reliable, the widest adoption of machinery is of the greatest advantage, not only to the manufacturer, but to the worker and the State.

A Fourteenth Century Law Case.

By H. Littlehales.

Very rarely indeed do we find any references in mediæval documents to specified repairs to metal objects. Certainly the bare mention of the cost of the repair of various objects is set down at times in ancient accounts, but anything like a story of the repairs executed is seldom given, and when such occurs, it is from its rarity of quite exceptional interest and value.

For this reason an account of the repair of a valuable metal and crystal pyx, printed from the still surviving documents of the mediæval county court of the ancient borough of Nottingham, naturally has a special attraction for anyone interested in the history of metal work. We find the particulars of our story in Vol. I of the records of Nottingham edited by Stevenson in 1882.

It seems that the pyx of the little priory of Lenton, near Nottingham, having fallen into disrepair, it became necessary to have it mended. Accordingly the little vessel was conveyed by Peter the prior and a monk of the name Dawnestes to the shop of Walter the goldsmith in Nottingham, where agreement was made for its repair. This was in the spring of the year 1355.

When in due course the pyx was sent home, the prior, and we may suppose some of the monks, declared that in place of using some gold coins supplied, the goldsmith had merely used a halfpenny! Great was the dissatisfaction.

After some considerable argument with the goldsmith, conducted, there is reason to believe, not wholly without acrimony, both parties took their case into what then answered to our modern county court.

The case was opened by the prior relating the tale of the journey to the Nottingham shop and how he arranged with the goldsmith that the repairs to the metal work should be of silver, which was to be gilded over, and for this purpose the prior had handed to the goldsmith two gold coins of the period (two nobles). The tale of the halfpenny was then related.

The goldsmith had also, said the prior, broken "the agreement thereupon made between them in these three particulars:—

(1) In not making the said vessel of pure silver.

(2) Nor well and suitably gilding it.

(3) And in soldering the aforesaid vessel with tin, whereas he should have soldered it with silver."

Two points of interest may be noticed in the above. One that even in those days the legal jargon appears in full flood; secondly, that in spite of it the cup is spoken of improperly as made of pure silver, when it is repeatedly stated that the vessel was of crystal in a frame of silver.

In answer to all this, Walter the goldsmith states that the prior really owes him 36s., which was the price agreed on for the execution of the repairs. And this 36s. was to be paid on the Monday in the first week in Lent of that year, and that it never has been paid at all.

Unfortunately the conclusion of the action is not given, but our interest lies rather with the details of the repair than the result of the legal action.

Two cups of a somewhat similar character to that of Lenton remain in existence; one at Yateley Church, in Hampshire, another in Goldsmiths' Hall, London.

German Foundry Employers' Federation.

The fifty-seventh Annual Meeting of the Verein Deutscher Eisengiessereien Giesserverbands (German Foundry Employers' Federation), will be held at Stuttgart, under the presidency of Dr. Werner, on June 1 and 2. Three technical papers will be submitted. They are (1) Basic Questions pertaining to the Rationale and Internal Transport in the German Foundry Industry, by Prof. Dr. Ing. Heidebroek; (2) Graphite Separation on Overheating of Grey Iron and its Significance to the Automobile Industry, by Dr. Ing. T. Klingenstein, and (3) The Fettling Shop and Its Development up to date, by Direktor Sepp.

Britishers who would care to be present should communicate with Dr. Geilenkirchen, 29, Breitestrasse, Dusseldorf, Germany.

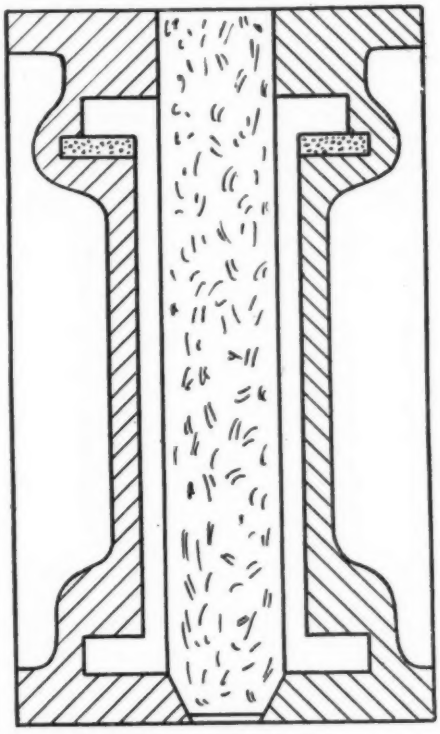
Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Holley Moulds.

To the Editor of The Foundry Trade Journal.

Sir,—On page 298, April 7, 1927, Mr. W. J. Paulin asked how a straight pipe with two flanges could be cast. The same question was put to me at a meeting in Manchester, September, 1925. I



answered that a ring core against one end of the flange would solve the question, as shown on sketch herewith:—

The cost of this small ring core would be negligible.

One point that does not appear to have been brought out at the meeting, was that the moulds so far have been made of the same iron as the castings. This, of course, is for the reason of convenience.—Yours, etc.,

Holley Carburetor Co.
S. M. Udale.

Detroit, Michigan.
April 21, 1927.

Blast-Furnace Practice.

To the Editor of The Foundry Trade Journal.

Sir,—On page 361 of the current issue you quote Mr. C. S. Gill's statement, made in reply to the discussion on his Paper "Blast-Furnace Practice at Consett," that he did not consider charcoal could absorb iron in charcoal blast furnaces, as suggested by me.

No suggestion to this effect was made by me. The query was, as is correctly given on page 360, whether the charcoal *adsorbed* some of the iron, which is quite another phenomenon.—Yours, etc.,

Victor Stobie.

Dunston-on-Tyne,
April 29, 1927.

Mr. John Shaw, who has for many years been foundry manager to Brightside Foundry & Engineering Company, Limited, has retired, and in future will live at Mount Vernon, 15, Western Parade, Southsea. He has been presented by the directors and his colleagues on the staff with a handsome parting gift. He is being retained by the company in a consulting capacity. Mr. Shaw was honoured last September by the American Foundrymen's Association by an award of a gold medal in recognition of the value of his researches to the foundry industry of the world.

The Heat Treatment of Grey Cast Iron and Semi-Steel.*

By O. W. Potter.

The primary objects of heat treatment may be stated as follows:—(1) The removal of casting strains; (2) to obtain the desired uniform hardness and the elimination of hard spots so as to facilitate machining; (3) to prevent or control casting growth; (4) to allow greater accuracy of machining and the elimination of warpage or distortion, after machining; (5) to provide for the necessary machining and subsequent heat treatment for castings required to be extra hard; and (6) to control the variation of properties of the metal.

After reviewing the literature and realising the difficulties of the casting user, and recognising the possibilities of improved properties through heat-treatment the following research was made, the object being to obtain definite data of the properties involved along with chemical analyses and a microscopic study. The main idea was the checking of results already reported and assisting as far as possible in determining a proper commercial treatment for specific purposes. It is hoped also that the information will be ample and convincing enough to cause a more general use of the process of heat treatment for grey cast iron.

The results of the first series of tests were presented before the American Foundrymen's Association at Syracuse, N.Y., at their 1925 Convention.

A miscellaneous set of specimens was subjected to ten different heat treatments. The final conclusions of this research are as follows:—

Conclusions.

(1) Proper heat-treatment can greatly improve the general properties of grey cast iron and semi-steel. One of the important results is a uniform hardness and the elimination of massive cementite under annealing.

(2) Properly to heat-treat, the correct critical temperature must be located and the temperature carried only enough above this to ensure all parts being heated above this point. This can be determined by ordinary thermal analysis.

(3) The critical temperature of grey cast iron and semi-steel can be calculated with a fair degree of accuracy from the chemical analysis according to the following formula:—

Critical temperature = 730 deg. C. + (28 deg. X per cent. Si.) – (25 deg. X per cent. Mn.).

(4) Carbon is oxidised when subjected to a quench from just below critical temperature.

(5) The best combination of properties was obtained by heat treatment T-1 (heated to 870 deg. C., held for three hrs., cooled to black in furnace and then air cooled). This was the heat treatment recommended by the Schaap process. This produced a uniformly soft product with only a slight reduction in strength properties.

(6) Holding at high temperature for long periods of time or cooling very slowly such temperatures produces extreme softness, but also greatly reduces the strength properties.

(7) To overcome the difficulty of dimensional changes, grey cast iron may be machined, and then subjected to a quench to produce hard iron which is not affected by intermittent heating and cooling below the critical.

(8) The properties of both grey cast iron and semi-steel can be greatly varied by heat-treatment, and the possibilities of improving and controlling these properties offer great prospects of practicability. To do this, additional systematic research is necessary for the co-ordination of chemical composition, physical properties, and correct heat-treatment along with a study of the micro-structures. This, along with the use of the ferro-alloys in cast iron and semi-steel will help to extend their field of usefulness and prevent somewhat the further encroachment of the other metals and alloys.

A second set of specimens was obtained and the following experiments were made:—

Six different sets of test bars, produced under ordinary production conditions, were obtained from five different plants. The arbitration test bar (1¼ in. diameter by 15 in. long) cast on end according to the recommended practice of the American Foundrymen's Association was used. Thirty test bars of each metal were cast from the same ladle to ensure as near as possible the same material for the tests. These were then divided in groups of three and nine sets (27 bars), and were given nine different heat treatments as follows:—

(1) Annealed at 260 deg. C.; (2) annealed at 538 deg. C.; (3) annealed at 734 deg. C.; (4) heated to 871 deg. C., and cooled slowly in the furnace (24 hrs.); (5) heated to 871 deg. C., held for 2 hrs., and air cooled; (6) heated to 871 deg. C., water-quenched, and tempered at 315 deg. C.; (7) heated to 871 deg. C., water quenched, and tempered at 538 deg. C.; (8) heated to 871 deg. C., water quenched, and tempered at 704 deg. C.; and (9) heated to 871 deg. C., held for 3 hrs., and air cooled. Reheated to 871 deg. C., and water quenched. (These were so hard they could not be machined, and were re-annealed at 870 deg. C.) The re-annealed bars were marked 9a.

Chemical Analysis.

The chemical analyses of all specimens are given in Table I. The effects of heat treatment on the chemical analysis are as follows:—(1) Annealing at any temperature reduces the combined carbon: (2) combined carbon is practically eliminated at anneals of 734 deg. C. or above; (3) slow cooling is necessary for the complete reduction of the combined carbon; (4) there seems to be a slight tendency to reduce total carbon on quenching due to surface oxidation; and (5) combined carbon is greatly increased by quenching from above the critical temperature.

The elements other than carbon were ascertained for several of the heat treatments to determine if any appreciable change occurred in total content, but none was found. It was thought that certain reactions might take place between the elements and the circulating gases at high temperatures. Since it is known that cast iron is quite porous, the circulating gases no doubt have some influence on the constituents. There may be oxidation or absorption of gases, but we had no means of determining this. Recent investigators have shown that the gases do have a very important influence on the properties of alloys.

The form and condition of the constituents are somewhat affected by the various heat treatments as appears in the micrographs exhibited.

Transverse Tests.

These tests were carried out on the standard arbitration test bar. They were rough bars, 1¼-in. in diameter, tested between 12-in. supports on an Olsen autographic testing machine. The small machined bars (0.505 in. in diameter) were tested between 6-in. supports on an Amsler autographic wire-testing machine.

The original arbitration test bars were made in green-sand moulds, and varied considerably in diameter. In order to determine the exact amount of variation, the diameter of each bar was measured at the fractured section. These results showed considerable variation, and no doubt had some influence on the final results. It is the author's recommendation that test bars should be made with greater care and that they should be made in a dry-sand mould preferably, and the patterns made without draft and stripped from the mould. This would no doubt give more uniform results and the tests would be more accurate and useful for comparisons. The broken pieces resulting from the test on arbitration bars were machined to 0.505 in. diameter and tested on 6-in. centres.

Results and Conclusions of Transverse Tests.

(1) Annealing below the critical point increased the transverse strength slightly. The maximum

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* Abstract from the annual Exchange Paper presented on behalf of the American Foundrymen's Association to the Brussels Congress of Association Technique de Fonderie de Belgique, Mr. Paul Ropsy presiding.

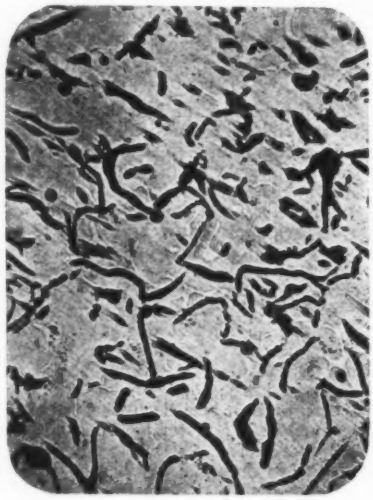

Fig. 1. Sample A.—Untreated. Etched and Polished × 100.

Fig. 2.—Sample A.—Untreated. Etched with Picric Acid × 500.

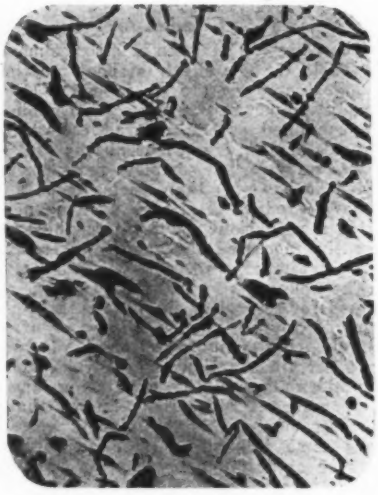

Fig. 3.—Sample A1.—Annealed at 260 deg. C. Relief Polished × 100.

Fig. 4.—Sample A1.—Annealed at 538 deg. C. Etched in Picric Acid × 500.

Fig. 5.—Sample A4.—Heated to 870 deg. C., and Cooled Slowly in Furnace. Relief Polished × 100.

Fig. 6.—Sample A4.—Heated to 870 deg. C., and Cooled Slowly in Furnace. Etched with Picric Acid × 500.

Fig. 7.—Sample A5.—Heated to 870 deg. C., held for two hours. Air Cooled. Relief Polished × 100.

Fig. 8.—Sample A5.—Heated to 870 deg. C. Held for two hours. Air Cooled. Etched with Picric Acid × 500.

Fig. 9.—Sample A6.—Heated to 870 deg. C. Water Quenched, and drawn at 315 deg. C. Relief Polished × 100.

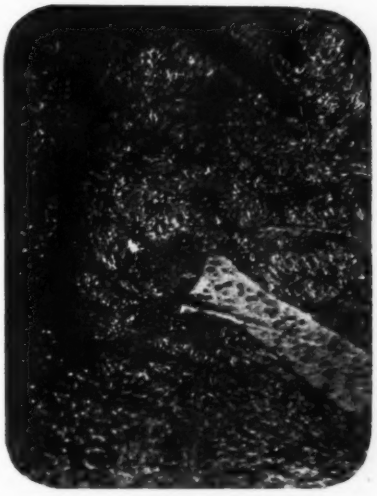

Fig. 10.—Sample A6.—Heated to 871 deg. C. Water Quenched, and drawn at 315 deg. C. Etched with Picric Acid × 1,000.

Fig. 11.—Sample A7.—Heated to 870 deg. C. Water Quenched, and drawn at 538 deg. C. Relief Polished × 100.

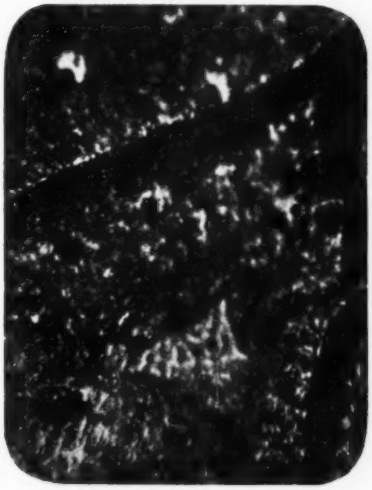

Fig. 12.—Sample A7.—Heated to 870 deg. C. Water Quenched, and drawn at 538 deg. C. Etched in Picric Acid × 100.

increases in strength were observed at 538 deg. C. The maximum variation occurred when the test bars were very irregular in shape, having swells and strains, and when the metal of these two series seemed somewhat oxidised, as was evidenced by frequent blowholes. Oxidised metal is known to increase shrinkage difficulties, and as a result increases the internal strains due to casting.

ing, and it is possible that if the complete details of Mr. Schaap's experience were obtainable the apparent difference would be explained. Extreme softness was brought about in these specimens when again annealed at 871 deg. C. The results agree very closely with those of the straight anneal with slow cooling.

The deflections obtained in these tests are con-

Table I.—*Chemical Analyses.*

		A (SS)*	M (SS)	P (CI)*	1S (CI)	2S (SS)	U (CI)
Untreated (as Cast) ..	Si	1.58	1.84	2.77	1.72	1.26	2.33
	Mn	0.80	0.42	0.71	0.59	0.64	0.56
	P	0.276	0.261	0.527	0.140	0.20	0.295
	S	0.072	0.112	0.070	0.114	0.101	0.096
	C.C.	0.80	0.90	0.29	0.75	0.80	0.48
	G.C.	2.49	2.37	2.85	2.77	2.68	2.89
	T.C.	3.29	3.27	3.14	3.52	3.48	3.37
	Ni	—	—	—	—	—	Tr.
	Cr	—	—	—	—	—	0.62
	V	—	—	—	—	—	0.68

* Those marked SS are semi-steels and those marked CI are ordinary grey cast iron.

When these strains are released, the greater the internal strain the greater the recovery in strength.

This test shows that there is a marked decrease in strength when the material is annealed at 734 deg. C.

(2) Annealing above the critical temperature followed by slow cooling greatly reduces strength, the only exception being a high-silicon iron, which showed a decided increase in strength for the rough bars. On the other hand, the annealing above the critical temperature with rapid air-cooling gave only a slight reduction in strength properties on the large bars, with the exception of a series which contained the elements Cr, V, and Ni. The above treatment is recommended by the Schaap process where softness is required with a minimum reduction of strength, and this investigation substantiates this recommendation. Here again it is interesting to note that the high Si irons show an increase in strength over the original strength rather than a reduction. The variation in the

siderable, but somewhat less than those annealed at 871 deg. C. and cooled slowly.

Tensile Tests.

The tensile strength varies considerably, as would be expected on material of such varying composition. They show essentially the same tendencies as the transverse tests. These results might be considered more comparable with other tests than the transverse tests on rough bars since they are machined bars and all the same size. Table II shows the average results, and the percentage of increase or decrease in strength over the original strength.

The anneals below the critical point at 260 deg. C. and 538 deg. C. show a slight increase in strength. A substantial reduction in strength is shown when annealed just below the critical point 734 deg. C. The soaking in the furnace from above the critical point gives maximum reductions in strength. The U series (see Table I) did not seem to behave in the same manner as the other specimens, no doubt due to the alloying elements.

Table II.—*Table of Per cent. Increase or Decrease in Tensile Strength.*

As cast. Tons per sq. in.	A (SS)* 13.2	M (SS) 12.8	P (CI)* 7.1	1S (CI) 11.2	2S (SS) 12.4	U (CI) 8.7
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1. Annealed at 260 deg. C. ..	+ 1.5	+ 4.0	+ 7.0	+ 2.7	+ 1.2	− 3.3
2. Annealed at 538 deg. C. ..	+ 7.7	+ 6.1	+10.9	+ 4.8	+ 2.5	− 0.50
3. Annealed at 734deg. C. ..	−17.0	−29.3	+ 2.6	−22.9	−23.9	−18.0
4. Heated to 871 deg. C. cooled slowly in furnace for 24 hours ..	−40	−36.6	+ 2.7	−32.1	−40.2	−31.6
5. Heated to 871 deg. C. held for 2 hours, and air cooled	−10.5	−30.1	+ 5.1	−22.8	−24.6	−15.5
6. Heated to 871 deg. C. water quenched, drawn at 600 deg.F..	+ 2.0	+17.4	+28.6	+14.1	+ 9.0	+34.0
7. Heated to 871 deg. C. water quenched, drawn at 538 deg. C.	+ 4.4	− 4.3	+16.3	− 1.8	+ 3.7	0
8. Heated to 871 deg. C. water quenched, drawn at 704 deg. C.	−26.7	−35.8	− 6.1	−26.8	−32.0	−22.3
9. Heated to 871 deg. C. held for 3 hours, air cooled. Re-heated to 871 deg. C. water quenched. Re-annealed at 871 deg. C. ..	−33.5	−34.8	+ 1.4	−29.7	−34.6	−22.8

* Those marked SS are semi-steels and those marked CI are ordinary grey cast iron.

results of the tests on the rough and machined bars on low anneals may be due to the ageing of the small bars before tests were made.

(3) The double treatments (quench and re-heat) were rather erratic. A general tendency is noted towards a decided increase in strength for quench and draw at 315 deg. C., while a reduction in strength occurs as the temperature of the draw is raised.

The reduction in strength appears to be a maximum when drawn at a temperature just below the critical point. These results were similar to those obtained for a straight anneal at about the same temperature.

(4) The specimens annealed at 871 deg. C., air cooled, and then reheated and quenched from 871 deg. C. were exceedingly hard, but very weak as shown by the transverse tests. This seems to be contrary to the claims made for the Schaap process, in which it is stated that after annealing at 871 deg. C. the material could not be re-hardened by subsequent quenching. The writer has repeatedly produced hard iron after anneal-

The most remarkable phenomenon was obtained with the high silicon irons (2.77 per cent. Si), which showed an increase in strength for every treatment except one, and in particular the long anneal from above and just below the critical point which gave great reductions in strength for the other specimens showed an appreciable strengthening in these specimens. This should be of great interest to users of high-silicon irons.

The air-cooled treatment from above the critical shows an average reduction in strength of 12.3 per cent. for all specimens.

The elongation in tension was carefully measured with a stage micrometer, and found to be very small. It varied slightly and followed generally the deflection in transverse testing. There probably is a slight elasticity but this was not recorded, because of difficulty in attaching reporting apparatus. There no doubt is a yield point just before the specimen breaks, as there was a very noticeable drop of the beam in most cases just before the specimen broke.

(To be continued.)

Foundry Purchasing.—VIII.

By ERIC N. SIMONS.

One of the main factors influencing the buyers' choice of suppliers will be the publicity which each gives to his wares. Most buyers have delivered to them regularly certain trade or technical publications covering their particular requirements. According to their characters, they either ignore or read with intelligent discrimination the advertisements that form an indispensable part of these periodicals. Similarly, there are few buyers not assailed through the post by innumerable circular letters, printed circulars of the "envelope enclosure" or "folder" kind, "reminders," advertising blotters, novelties, and so forth. In view of the ever-increasing pressure of this publicity attack, it is essential to examine it calmly to see if any value at all can be attached to the messages it rams home.

Advertisements are the first and most important form of publicity. (Salesmen will be considered separately in a later article.) It is idle for a buyer to dismiss them lightly as of no importance. An advertisement is a means of securing distribution of factory produce. It is, or should be, the supplier's reasoned statement of why his goods are worth buying; in what lies their advantage, and under what conditions they can be obtained. This information is given in the fewest words, and, wherever possible, is emphasised or made more explicit by means of apt illustrations. The same information could only be obtained in the following ways: (*a*) By interviewing a salesman or other representative; (*b*) by correspondence; (*c*) by carefully wading through a catalogue or booklet; (*d*) by personal visit to the supplier's works; (*e*) by telephonic or telegraphic communication. Obviously, these five ways are either more expensive or more time-wasting than the simple procedure of reading an advertisement at convenience. To examine the advertisements of supplying firms is, therefore, neither wasteful nor useless. It is true that many advertisers have not yet learnt how to give in their announcements information of actual value to the buyer; but, on the other hand, many firms have learnt, and it is their advertisements that it will pay the buyer to read. A directory entry may give him a list of suppliers' names, but it does not give him information about the differences between the various suppliers listed. The advertisement pages of a trustworthy journal constitute not only an accurate and up-to-date directory of suppliers, they also aid the buyer to discriminate among suppliers, keep him informed of variations in design, alterations in standard prices, changes of address, improvements and modifications, extensions of plant (implying greater facilities for quick delivery), and, in short, much other matter concerning markets that it would take him weeks to collect in the ordinary course.

The same is true, in a less degree, of circular letters, printed publicity matter, and so forth. Here, as in the matter of advertisements, the buyer will have to learn to pick out the sensible, practical, and, above all, specific circular from the mere "boost" or "puff." If he can acquire the art of winnowing the wheat from the chaff quickly, he will find it worth while.

Another important part of the buyer's work is to go "on 'change." This enables him to get into touch with the leading suppliers of bulk or standardised materials, *e.g.*, fuel, pig-iron, scrap, and so forth, and sometimes to find out and buy odd parcels of these commodities at advantageous prices. In addition, he gathers information concerning the state of markets, prices, etc., of value to himself as a buyer.

The foundry buyer should also, from time to time, visit in person his chief suppliers or sources of supply. The advantage of this is that it enables him to check over the information concerning the markets that he has obtained from other sources, to obtain an insight into existing and possible future conditions, and to supplement his knowledge in many directions.

One now comes to the important matter of the buyer's personal authority. It will be seen at once that if no restrictions are placed upon his activities, he will have the ability to involve his employers in huge outlays, and to commit them in many directions. Furthermore, some precautions must be taken to prevent requisitions of a technical character, sent in by heads of departments or other works' officials, from being translated into official orders without examination of their implications. To put this more clearly, one might indicate the possibility of a departmental head or foreman or works official over-estimating the amount of material required, and making out requisitions for quantities that involve heavy financial liabilities or outlays, and are not justifiable in actual fact. If the buyer has no control at all over these requisitions, other than to affix his signature to the official orders before they are despatched, he will have no means of preventing his employers from being committed to expenses that he may feel certain are unnecessary.

The authority of the buyer calls, therefore, in efficient foundry management, for what might be entitled a superior limitation and an inferior extension. In other words, his personal authority to spend must to some extent be limited by those above him, and his personal authority to prevent or control expenditure must to some degree be extended to those below or of equal rank with him.

These are both difficult and delicate matters, and practice in their regard is subject to considerable variation, according to the character and methods of the particular firms concerned. In a later article an attempt will be made to describe how the board of management of one foundry in particular check the expenditure of the buyer in every direction, without personally interfering with his arrangements, so long as these are sound and keep in mind the actual financial position of the concern. In other instances, the buyer has complete authority to spend, and there are no restrictions, actual or implied, upon his purchases. But this, to the writer's mind, is a dangerous practice, since it assumed what cannot always be guaranteed—that the buyer has a thorough knowledge of his firm's finances and is never likely to prove rash in his actions. In the majority of cases the buyer, however able, is not so intimately in touch with the financial policy and resources of the management as the management themselves; and, therefore, he is not always in the best position to know whether a heavy advance purchase, which in normal circumstances might effect a considerable saving, will or will not financially embarrass the company for which he is working. It is to guard against risks of this kind that the buyer has been recommended to study the financial policy of his employers, in so far as it is open for him to study. Similarly, where the buyer cannot—for various reasons—be given a close insight into the finances of his firm, some check upon his activities should exist. The need for this check is specially important in the case of a large combine or big firm whose financial arrangements are exceptionally intricate, and whose demands for loans from its bankers are fairly frequent. It is not easy to say what form this check or restriction upon purchases should take, though, as has been mentioned, one method to be described later has proved efficient in practice. In some firms the policy is adopted of dividing purchases into two sections—general and special. The average weekly or monthly expenditure on general purchases (which comprise materials regularly used in fairly consistent quantities) is estimated, and this (plus or minus a small percentage to cover fluctuation) is fixed as the maximum weekly or monthly allotment for purchases. The buyer is given full liberty to spend up to this maximum amount as he pleases: but before he can spend a penny more, he must consult the higher officials, with reasons and explanations, upon the soundness of which, or upon the financial position of the firm, will depend their consent. Special purchases comprise very heavy expenditures on materials for urgent needs, or for the execution of big contracts. For example, a firm entrusted with the contract for the supply of a huge number of locomotive castings has necessarily, before ever it begins to handle the profit on the transaction, to lay out big sums on raw materials, labour, power, etc.

Obviously, no monthly average or maximum purchasing expense would cover so sudden yet so essential an outlay. Therefore, in many foundries, the rule is that purchases of this kind shall only be made at the instigation of either the board of management direct, or of the accountant, the buyer, the production managers, and a representative of the management, in consultation. The advantage of this scheme is that it brings the buyer into touch with the other officials, and gives him an insight into the financial responsibilities involved in undertaking a big contract, thereby making him more careful in his purchases.

To conclude this article, it will be advisable to indicate briefly the relations of the buyer with the departmental managers. The sketch on this page (Fig. 1) shows in a simple and readily comprehensible way how the buyer is situated in relation to the business as a whole, and his own department in particular. In the following article closer examination of the implications of this situation will be made; for the present it is sufficient to say that he should lose no opportunity of getting into intimate touch with the heads of all requisitioning departments, so that he may more clearly understand their needs, see the goods he buys for them in actual use, obtain first-hand information concerning their performance, and do his best to make a favourable impression, so that they will aid him in, rather than hinder, his labours. Precisely because it is difficult for him to find the time to visit these various departments with the necessary regularity has the regular monthly conference been inaugurated in some foundries; but if this monthly conference cannot be initiated or maintained, he should do his best to visit the departments in person at least once a month. By so doing he will be better able to overcome objections to new products, to grasp the reason for departmental insistence upon particular suppliers, and, in short, to make himself more valuable to the business than would be the case if he remained in his own office, acting as a sort of impersonal pillar box for requisitions.

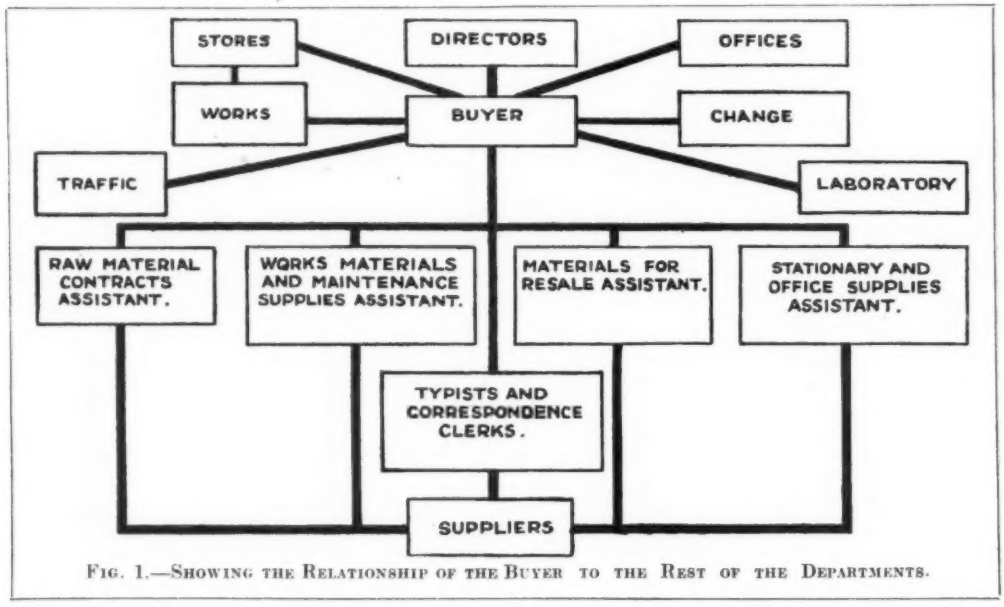

Fig. 1.—Showing the Relationship of the Buyer to the Rest of the Departments.

During the past four or five weeks Foundry Plant & Machinery, Limited, of 100, Wellington Street, Glasgow, have disposed of nine sand slingers, and the destination of these machines is rather interesting because of the wide variation of application, which includes the following trades:—Crane builders; paper machinery makers; agricultural engineers; locomotive builders; marine steel founders; railway wagon builders; aluminium founders; and two firms of motor cylinder manufacturers. Such a comprehensive range is obviously an indication of the widespread application of the sand slinger.

French Foundry Students' Tour.

During their Easter vacation the students of the Ecole Superieure de Fonderie visited the industrial region of the North of France, under the leadership of Mr. Ronceray and one of the lecturers, Mr. Debar. The tour opened at the works of La Ste. du Fomilistere de Guise, Collin & Company, where the welfare department was much admired, Mr. Godin, the founder of the company, having instituted the scheme with beneficial results.

The second day was spent in the Vimen district, where the shops of Messrs. Imbert, of Friville (lock makers and coppersmiths), C. Milbled (malleable castings), and the Saint German concern (manufacturers of small nickel-plated fittings) were visited. Saturday was spent in Boulogne, where they first visited the Paris-Outreau steelworks, and afterwards the works of Compagnie française des Compteurs, at Marquise. Mr. Pernin, during "tea," gave a history of the works, which dates back to 1830, and referred appreciatively to the name of Guettier, who is known as the "father of foundry work." The next day was spent in the outskirts of Lille, where the works of the Compagnie Internationale des Machines Agricoles, at Croix, were inspected—an important concern manufacturing agricultural implements on the most modern lines. The Fives Lille iron and steel foundries were included, and the pattern storage arrangements, carried out in reinforced concrete, were favourably commented upon. The last visit in this district was to the brass and special alloy foundry of Messrs. Cocard. At Valenciennes, the modern blast furnace plant, steelworks and rolling mills of the Forges et Acieries du Nord were inspected.

The last day was devoted to visiting the Ste. Française de Construction Mecaniques and the Hauts Fourneaux et Acieries de Denain and Anzin. The former concern is definitely modern and possesses an important welfare department and a model apprenticeship system. The latter works, which were built in 1925, has the latest type of blast furnaces, steelworks and rolling mills, and served by the latest labour-saving devices.

The object of the visit was to demonstrate the relationship which exists between the foundry and the large works, and is well worthy of emulation by the universities and technical schools of Great Britain. We have been asked to organise a similar tour for these French students in an industrial region of Great Britain, and feel that the time is opportune for a group of British foundry students to get together and ask for reciprocal hospitality on the French side—a request which we are certain would receive enthusiastic acquiescence.

The Manufacture of Large Iron Castings.*

By Henri Fabre.

Object.

It is not the author's intention to deal exhaustively with the manufacture of large castings. His object is a far more modest one, and is confined to an attempt to elucidate certain points which appear to be of special importance. It will be understood that by "large castings," he does not necessarily mean very heavy castings. It is probably much easier to make a 60-ton anvil-block than a turbine part weighing 5 tons or a locomotive cylinder of 1,800 kilos. The observations apply more particularly to castings of large dimensions and awkward to mould, their weight varying from one ton only to the maximum upper limits.

Organisation and Shops.

No founder should start manufacturing large castings unless he intends to continue such manufacture and possesses the material means necessary to do so. He can then make plans and arrangements accordingly. A foundry which has not been designed or equipped for large castings, and which tries to manufacture them spasmodically, without the necessary means and organisation, will meet with nothing save disappointments.

Floor.—This must be perfectly dry. Care should be taken to ascertain that there exists no water at a depth of less than 30 ft., and that no infiltrations are possible owing to the vicinity of any stream or other watercourse. The nature of the ground selected should if possible be compact and of good consistency, as this may be of importance in order to avoid the creation of shallow pits.

Building.—The building should be lofty and allow a clearance of at least 26 ft. under the crane hook, and, in sime cases, more. Adequate lighting during daytime should be provided by means of large side lights and overhead glass panels, and at night by sufficiently powerful and suitably distributed lamps.

Ventilation.—Careful attention should be given to proper ventilation, so that the large quantities of noxious gases given off during drying and pouring may be evacuated.

Water Drainage.—Water should be drained off, both inside and outside, by gutters of sufficient size to prevent choking. These gutters should be inspected and cleaned at frequent intervals.

Compressed Air.—A compressed-air system should be installed, provided with numerous tapping points.

Hydrants.—There should be a sufficient number of hydrants in order to reduce transport.

Loam Moulding Shops should be separate from those intended for sand moulding, on account of the different plant and materials required for each of these two methods of casting and in order to avoid double handling. The general arrangement will provide for core shops, which take up a lot of space.

Pits.

If the soil is sufficiently compact and solid it will be found sufficient, for pits of 6 ft. and less in depth, to dig straight into the ground and eliminate boxing-in. In only a few cases, however, is it possible to construct large pits 12, 18, or 22 yds. deep without reinforcement. The pressures in the lower parts of large moulds are sometimes enormous, and strong reinforcement is therefore necessary. In regard to boxing-in, this is to some extent a question of cost. All systems are good, be they cast-iron, caissons of sheet-iron, masonry, or concrete, etc., so long as they are well constructed. At all events, strong walls will thus be obtained, and stripping will be facilitated by smooth walls enabling the sand to be easily removed.

The most important point is to have watertight pits. If, however, there are any infiltrations in the immediate vicinity, this condition will be difficult to satisfy, and it is therefore advisable to make provision, in one corner, for a sump which must be carefully drained. This can easily be effected by the compressed-air system.

Bolting-Down.—All pits should be provided with bolting-down plates. The vertical pressures often reach very high figures, from 80 to 100 tons and more. Bolting-down plates, although they entail an initial expense, ensure in the first place definite certainty in the stability of the moulds. They also prevent the getting together of hundreds of tons of weighting down metal, economise the space taken up by the moulds, and, finally, avoid in each case lengthy and costly handling.

Transport Equipment.

This problem, which is of the greatest importance, is often imperfectly solved. Provision must be made for two kinds of apparatus:—those intended for general transport, and those serving for transport in the shops.

The former comprise the travelling cranes used for heavy work, the transport of ladles and heavy moulds to the stoves, the stripping and transport of large castings and moving of heavy materials, etc. The capacity of these apparatus will be decided by the limits of tonnage it is intended to handle. In practice, it is advisable to provide one traveller for every 100 ft. length of shops. Their travelling and racking speed should be fairly high—say about 190 ft. per minute. As to their hoisting speed, this should also be considerable and reach about 6 ft. a minute if they are only used for the general purposes referred to above. If they are to be used for stripping this speed will be too high.

The second category of apparatus comprises those which are reserved for detail work in one or more shops. Either telpher or jib cranes may be adopted. The former have the advantage of being able to serve several bays, but in spite of this they are often found to be insufficient. They necessitate, moreover, the continual presence of a crane driver. Jib cranes, on the other hand, though only serving one or two bays, can be worked from the ground by a boy or workman told off for this purpose in each shop, without interfering with the work of the rest of the staff.

The core shop should also be provided with one or more cranes. If care is taken to place the core drying stoves close by, this shop will be independent and cause no inconvenience.

Plant and Materials.

It would be superfluous to describe the plant, in the first place because there is no fixed rule, and secondly because very frequently special castings have to be made. There are, however, two distinct categories of materials:—(a) Those used for sand castings or combined loam and sand castings, and (b) those used for loam castings.

Under (a) there are the boxes. These should be very carefully made, of the best cast metal, and should be sufficiently strong. To economise a few kilogrammes of metal here is a mistake, if, by so doing, the success of subsequent operations is jeopardised. The question of ease of handling does not arise here, as all the operations are carried out mechanically.

All handles and lugs, etc., should be of ample dimensions and well finished. The pins and bars in particular, should be carefully thought out.

The copes should be made up of plates bolted together, which not only simplifies their manufacture but also greatly facilitates stripping. In view of the high lateral pressures they occasionally have to bear, they should be of adequate thickness and well reinforced.

Boxes are seldom used for loam castings. On the other hand, it is necessary to make cope and drag plates. In regard to these plates, even before manufacturing, a series can be prepared in advance* to serve for current requirements, especially in the case of covering plates. For example, a series of plates can be made for cover-

* A paper read before the Brussels meeting of the Belgian Foundrymen's Association, M. Paul Ropsy presiding. M. Fabre is Foundry Manager to the Ste. Bracq-Laurent, Achicourt (Pas de Calais).

ing from 6 to 9 ft., another series covering from 7 to 10 ft., and others covering from 8 to 12 ft., etc.

In regard to core plates, it is better to make these as required, as the dimensions have to be very exactly determined in accordance with the actual castings.

When manufacturing these materials the handling they will have to undergo must be taken into account. Thus, in the case of covering plates which have to be handled flat, turned over, etc., the following must be provided:—

(1) Lifting lugs A (Fig. 1) with large eyes which can also be used for holding down; (2) two special lugs B to enable the plates to be easily turned; and (3) two lugs C, for turning it over and through which can be passed a bolt which can be handled direct by the crane hook.

Patternmaking.

It is impossible to draw up any fixed rules on the subject. The final decision will be dictated by an exhaustive study of all the conditions and details of manufacture, including labour. All details must be provided for in order to avoid cutting or adding in the mould at the last moment.

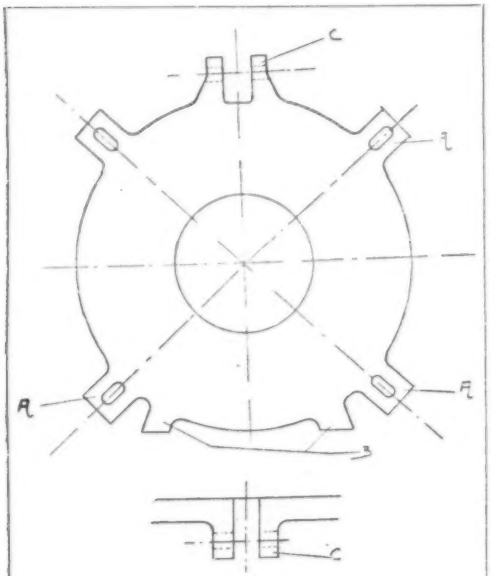

Fig. 1.

Contrary to generally accepted opinion, the pattern of a large casting should always be very well finished. In the case of complete patterns for delicate or complicated castings, such as steam cylinders or turbine parts, this will readily be understood. If it is merely a question of a casing, this should be strongly made, well braced and reinforced in order to prevent distortion.

The strickles should be strong, iron-edged, even for a single casting, the bosses or prints having their positional diameter traced on the sweeping board.

To sum up, a few extra hours devoted to patternmaking should not be grudged in order to avoid days of work in moulding and, above all, in order to avoid errors.

Moulding.

Loam or Sand?—It is obviously impossible to answer this question categorically. In the first place, the choice will often be decided by the labour available. Some indications, however, may be given as to those cases in which loam moulding is generally preferable to sand moulding:—(1) In the case of castings of large dimensions requiring considerable time for moulding, as loam moulds are stronger, and more easily prepared; (2) in the case of complicated castings, showing difficulties in assembling, for the same reason as that just given; (3) in cases where there being only one casting to be made, it is desired to cut down patternmaking expenses as much as possible, as in loam moulding a few templates, jigs, or strickles are all that is necessary; (4) in the case of castings having massive parts at certain points, especially at the side of the runners, which are washed by masses of metal, for the reason that loam is better able to resist the action of the latter; and (5) finally, in the case of series of castings, of simple geometrical shape, thus enabling special material to be provided, as loam permits this work to be entrusted to ordinary skilled workmen and considerably reduces the time necessary for moulding.

Besides the above advantages, loam moulding enables castings to be stripped much more easily.

In many cases it will be found advantageous to employ a combination—*i.e.*, loam and sand—moulding, delicate parts being cast in loam, and the rest in sand.

Raw Materials.

No matter whether loam or sand moulding is adopted, use must only be made of sand and raw material of excellent quality, carefully chosen and properly prepared.

The sand should be selected, graded, and tested with the greatest care until it is entirely suitable for the work to be done.

A few general rules may be given:—(1) Sand of different quality and properties should be stocked, so that different preparations may be made in order to suit different kinds of castings. Obviously the same sand should not be used for a turbine 1 in. thick as for an ingot-mould for 8 in. plates; (2) stocks should be very carefully inspected, samples taken, and tests and analyses

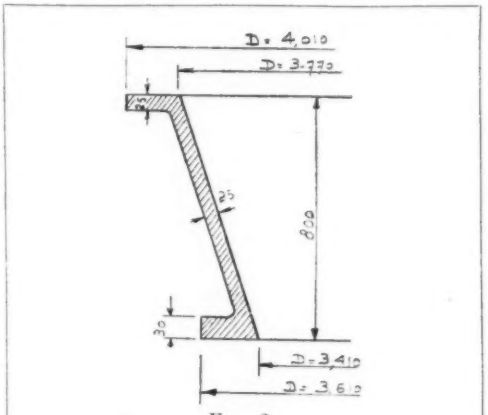

Fig. 2.

made frequently; (3) a strict watch should be kept on the sand shop, and care taken to see that the mixtures are well prepared. It must not be forgotten that the sand moulders in a foundry for large castings should be picked men on whom reliance can be placed.

Generally speaking, sand should possess the following qualities:—

Refractoriness.—In order to resist the action of large masses of metal.

Porosity.—In order to allow gases to escape easily.

As a corollary of the latter quality, coarse-grained sand should be chosen.

Special Precautions.

Runners.—These parts of the moulds can never be too carefully made, and, unfortunately, the contrary is generally the case. It must not be forgotten that, if a 10-ton casting is poured, each part of the mould only receives its corresponding amount of metal, but that the whole of the 10 tons passes through the runner. It is, therefore, indispensable that runners should be very carefully constructed, and the following points should be observed:—

The gates for the casting having been calculated a pattern should then be made. When erecting the moulds, place the gate pattern in position, ramming them into loam or sand, make a joint at the top, remove the pattern, set the runner box, dry, blackwash and cover with cakes

of loam, well finished and straightened, dried and blackwashed previously.

Where the main runners are made of loam, they should be made in the form of cylinders of sufficient thickness, carefully dried, blackwashed, and placed in position one above the other with all possible care. Before casting, the runners should be thoroughly dried by hot air blast by means of a portable apparatus.

Gauging of Runners.

This question has formed the subject of very interesting discussions. Many founders consider such gauging useless. The author disagrees, and thinks that in the case of large castings it is necessary to determine the section of the runners. Infinite trouble may be caused by undersized runners, which do not "suck," or, on the other hand, with the too rapid inrush of metal in a mould, especially if proper provision for the escape of the gases is not made.

Risers.—The question of risers and sink heads and their utility has given rise to much discussion. In the case of large castings, however, there is no doubt about the matter; it is necessary to provide risers which may be defined as channels or openings forming a communication between the interior of the mould and the atmosphere and intended to give free escape to the gases in the mould.

In these cases it is indispensable to determine the number and section of the risers. As a general principle it may be laid down that when a mould is filled the air and gases should be able to escape when under very low pressure.

As soon as the charge is poured into the mould it drives out the air contained in the latter. This is accompanied by the formation of gases which ought to be able to escape through the sand, but the outlet of which we nevertheless ought to facilitate as much as possible. Though the quantity of air decreases as the mould becomes filled, the total amount of air and gases to be expelled increases owing to the formation of gas.

In pouring a 10-ton casting, the space to be occupied by the metal is about 1,400 cub.dm. If the casting is poured 2 mins., the quantity of air to be expelled per second will be about 12 cub dm.

In practice, in order to estimate the quantity of the gases formed, the author applies to this figure the coefficient 1.5, whence there is 18 cub. dm.

Now $Q = S \times V$.

Under these conditions $S = \frac{Q}{V} = \frac{18}{2} = 9$ sq. dm.

The number of risers which is desirable or possible to provide being known, their section can be calculated, their thickness naturally being in proportion to that of the casting.

The consequences of inadequate air escape may be extremely serious, and are of two kinds.

In the first place, if the risers are too narrow, the air cannot escape quickly enough, with the result that eddies and pockets of compressed air will form all round the riser. If the metal is rather pasty, it will be compressed and entrapped. If it is very fluid, the air may penetrate it and remain occluded, thus giving rise to defective parts round the risers. Moreover, if the risers are too small and insufficient in number, fatal counter-pressures are produced in the interior of the mould, and may give rise to pockets, leaks, and lifting of boxes, etc.

Grids.

Large cores often require heavy grids. The properties which should be possessed by a good frame are the following:—(1) It should be sufficiently strong to enable all handling to be done without distortion resulting; (2) it must in no way prevent the shrinkage of the casting; and (3) it must be easily removable. As conditions Nos. 1 and 3 are to some extent contradictory, the grid must be carefully designed in order to fulfil both.

The second condition is of great importance. From 3 to 4 ins. of loam or sand must always be allowed between the casting and the grid. If moulding is being done in loam, straw should be wound all round the grid in order to enable the loam to become compressed. Hard bricks should never be placed directly in touch with the grid. Finally, the effects of shrinkage should constantly be borne in mind.

Shrinkage.

This is one of the worst nightmares of the founder of large castings. Shrinkage is fairly extensive, and may sometimes reach several centimetres. If it is not given every facility, it may give rise to the following troubles:—(1) Actual breakage; (2) more or less extensive distortion; and (3) the setting up of internal stresses which although invisible, may—sometimes a long time afterwards—cause breakage or accidents.

It is, therefore, necessary to consider how shrinkage may take place, and to carry out the moulding details in such a manner that it may not be hindered in any way.

In this connection, even greater attention must be given to loam moulding than to sand moulding. In the moulds certain parts should be made exclusively of loam bricks. In the more delicate portions spaces filled with small coke or crushed slag should be left immediately behind the loam.

As soon as the castings have set, the bricks or packings should be removed with tongs. If there are any inaccessible parts, such as the lower portions of certain castings, the greatest care must be taken in order to ensure easy shrinkage. Such lower portions should as a rule only be constructed of loam bricks, with 18 or 20 mm. joints between them, between which small coke without cement may be placed. The 20 or 30 mm. of loam placed on the bricks will be amply sufficient to bind them properly.

In the case of large cylindrical castings, the exterior will as a rule require no special precautions. The cores, on the other hand, should be very carefully watched, especially when dealing with large castings with thin walls.

In the majority of cases, these cores should be of loam. At least three vertical rows of loam bricks should be provided, which should be knocked out immediately after pouring. In this case also the thinnest possible brick-work should be used, leaving wide joints between the bricks not filled with cement. Finally, all parts likely to check shrinkage should be removed while hot.

The adverse effects which may be caused by runners and risers must not be forgotten. If these are of large section, and if shrinkage wedges them against a box, plate, or closely-rammed sand, contraction will be stopped. As a rule, therefore, risers should be broken whilst hot and sand or bricks between the runners and casting removed.

In the case of large cores, it has already been pointed out that the grids are of considerable importance. A wise precaution is to place them, wherever practicable, outside the castings, providing fairly large prints so that the whole of the sand is contained in them.

Defects.

It is not proposed to deal here with defects of a scientific nature, such as blow-holes, pipes, and porosity, the causes of which are the same both in small and large castings, but rather with those which are more commonly met with in large castings. Primarily there is the lack of conformity between the dimensions of the casting and those of the design, assuming, of course, that the pattern has been correctly dimensioned. But especially in loam castings of large size, differences of several millimetres are sometimes found. These are due to shrinkage, which essentially varies in accordance with the quality of the metal, type of moulding employed, and the manner in which it has been possible to strip the mould. As no precise rule can be given for these factors, success can only be obtained by making numerous observations and taking the averages of a large number of castings.

For example, we will consider the tank shown in Fig. 2. The order was for 12 castings, for which the same mixture of metals was used. The mould and core were made of loam. Ten minutes after pouring the top plate was removed, and the core eased at three points. The shrinkage allowed for was 0.6 per cent. Upon inspection the first casting showed 4.013 and 3.611 in the flange diameters. Nothing was altered. In the second casting, the diameters were 4.017 and

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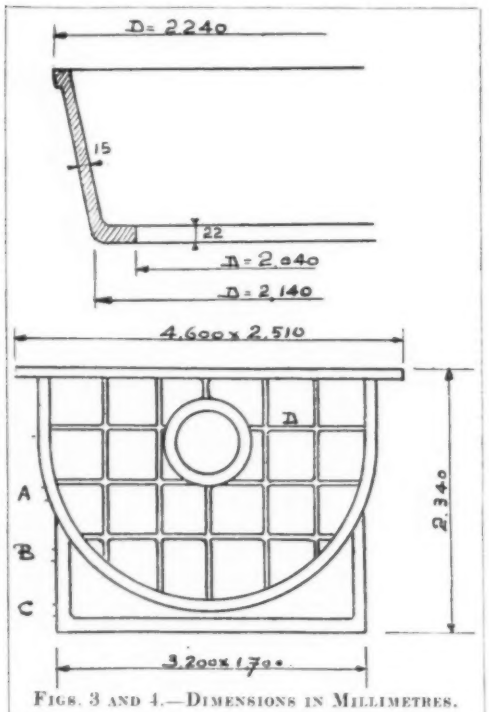
3.615. This discrepancy was too great, and the arrangement of the board was changed. The third casting, however, gave no more than 4.005 and 3.605.

It was only after making five castings and after arranging the setting of the core and other details with meticulous care that the author succeeded in obtaining more or less uniform castings, that is to say castings showing differences of not more than 2 or 3 mm.

The distortion which sometimes takes place in castings, may be due to either of two causes. First, faulty design of the casting and a want of harmony between the shape or dimensions of its different parts. In this connection we would once again emphasise how much the work is simplified if there is a complete understanding between the founder and designer, especially in the case of large castings. In the second place, distortion may be due to defective moulding or bad grids, etc.

As an example one may take the case of the ovalisation of circular castings, which is caused either by play existing between the strickle arms, between these and the upright, or by bad easing of the core during cooling. Such is the case of the crushing pan shown in Fig. 2. If the pre-



Figs. 3 and 4.—Dimensions in Millimetres.

caution is not taken of making three easings at 120 deg. in the core, and, for example, only two are made, an ovalisation of from 5 to 6 mm. is certain to result.

In the case of large strickled castings, if the moulder exercises irregular pressure on the end of his board, the result will often be warped and not perfectly flat castings. The third defect, which is an accentuation of the foregoing, is cracking. Cracks have the same origin as deformations.

Another defect which commonly occurs in large castings is the presence of sullage or slag inclusions. The skimming of a 15- or 20-ton ladle is an extremely delicate operation, which can never be really completely carried out. Skimming during pouring is often only illusory. In spite of all precautions, there still remains slag which finds its way into the mould. Much of this slag lodges in the risers or deadheads, but it is by no means rare to find inclusions in some part of the casting itself, giving rise to leakage, etc., at the point in question. The utmost care must therefore be taken in the construction of basins and runners, and in the skimming ladles.

We may take as an example the case of a tank for the impregnation of electric cables, of which the shape and principal measurements are shown in Fig. 4.

The weight is 17 tons. The casting was poured through 6-in. gates, two at A, two at B, and two at C. The most careful attention had been paid to the runners, basin, and ladle, etc.

Upon machining, the casting appeared to be faultless. Upon a 6.6 lb. hydraulic test being made, sweating was observed at D over a length of about 30 mm. The casting was drilled to 45 mm. in order to insert a screwed plug, and examination of the holes revealed the presence of slag which had stuck to the wall of the mould.

One method of pouring which eliminates many of the drawbacks due to slag, consists in using stoppered ladles or basins placed over the principal runner. The lighter slag floats on the top, and only clean metal passes into the mould. In many cases, however, it is necessary to have recourse to the ordinary ladle on account of the rapidity of pouring and filling, which is obviously limited when using a stoppered ladle.

Scabbed Castings.

This is one of the most serious defects, especially in large castings, which often have to undergo compression or impermeability tests. Scab may be due to any of the following causes:—(1) Faulty preparation of the loam or sand; (2) defective drying; (3) insufficient escape of gases; and (4) defective or irregular ramming.

Attention has already been called to the importance of the careful preparation of sand. In regard to drying, we consider that this should be the object of particular care. Drying should be perfect. There should be no hesitation in *roasting* the moulds both inside and outside before blackwashing

Flanges and pipes, which are often rather inaccessible, should be carefully attended to. It is often found that certain castings will require several days for final assembling. All traces of damp must, therefore, have disappeared. Once the mould is closed it is advisable to force hot air into the runners and casting until the last moment by means of an efficient portable dryer.

Scab due to insufficient escape of gases can be prevented by the constant supervision of the workmen, and by venting from top to bottom at frequent levels, starting close to the casting and gradually increasing in diameter towards the outside. In loam moulding the fissures caused by preliminary drying, before repairing, are often very badly plugged, which gives rise to the formation of air pockets which, becoming expanded during pouring, cause the loam to lift and scabs to form.

Finally, though ramming does not offer difficulty in loam moulding, it assumes the greatest importance in large sand mouldings, for which pneumatic rammers should be used. These excellent tools, in the hands of careless workmen, may cause serious defects by causing the formation of excessively hard parts close to the pattern. These hard parts prevent the normal escape of gases by closing up the sand pores.

Contracts Open.

Cradley Heath, Staffs, May 9.—(1) Pumping station at Hay Green, Lye, near Stourbridge; (2) pumping station at The Freehold, Quarry Bank; (3) storm-water tanks; (4) detritus tank, etc., for the Upper Stour Valley Main Sewerage Board. Mr. G. P. Deeley, the engineer, 13, Church Street, Stourbridge. (Fee £5, returnable.)

Littlehampton, May 11.—72 9-ft. lengths of 4-in. cast-iron water pipes, one 3-in. tee, and one 4-in. to 3-in. tee, for the Urban District Council. Mr. A. Shelley, clerk, Town Offices, Littlehampton.

Liverpool, May 11.—Boiler and feed pump, for the Baths and Washhouses Department. The Engineer and Chief Superintendent of Baths, 75, Dale Street, Liverpool. (Fee 10s. 6d., returnable.)

St. Helens.—400 yards 24-in. cast-iron main pipes and specials, for the Gas and Lighting Committee. The Gas Engineer, Gasworks, St. Helens, Lancs.

Warrington, May 7.—7,100 yards of 15-in. steel water pipes. Mr. J. Gray, waterworks engineer, Municipal Offices, Warrington.

The Holley Permanent Mould Process.

At a meeting of the Chemical Engineering Group of the Society of Chemical Industry, Mr. F. H. Rogers presiding, held in the private theatre of the American Film Company, Limited, on April 25, Professor J. W. Hinchley read a Paper on "Permanent Moulding Machines for Cast Iron," in which he described a plant used by the Holley Carburetor Company, of Detroit, U.S.A., for the making of small castings of cast iron in permanent moulds mounted on a rotating platform. He also exhibited a film showing the process of making these castings.

Process Described.

PROFESSOR HINCHLEY said that any method by which a reduction of the cost of production of machinery can be made must always command the respectful attention of every engineer. The cost of castings was an important item in the cost of production of a machine. The quality of these castings, in their accuracy of size, uniformity of material, freedom from porosity or blowholes, etc., also played a very important part in the ultimate cost of the machine. Any method by which the cheap production of castings was obtained without improvement in quality might be an advantage, but it was fortunate that in the mass production of manufactured articles there seemed to be a law that the very lowest costs were obtainable only by the highest achievements both in accuracy and in quality.

Preparation of the Mould.

The preparation of moulds for single castings, either in sand or in other material, was a very inefficient procedure, and every engineer who had faced the problem of large outputs must have considered the production of more or less permanent moulds. In the production of castings of low melting-point metals, permanent moulds presented few difficulties, and in some industries such moulds had been known for a very long time. The use of a horizontal rotating table upon which moulds were placed and subjected to different processes during the revolution of the table was a well-known scheme, the Wick's rotary type casting machine being an example in point. The use of permanent moulds for such materials as aluminium was also well-known, and there were great advantages to be obtained from such methods. It was an invariable experience that such alloys were stronger cast in chills than cast in sand. With cast iron, however, the difficulties of using a permanent mould were increased. Chilling of the metal and destruction of the mould were points of serious importance in the centrifugal casting process. The permanent iron mould was used, but the metal must be annealed after casting, or the product was useless. In the motor-car industry there was a great demand for the permanent mould, and such permanent moulds for cast iron offered considerable possibilities of economy in the production of the motor car and in the displacement of brass for many purposes.

The Holley Carburetor Company had developed such methods for the production of carburettors, and other parts, for the Ford car. There were usually twelve moulds on a rotating table. The table rotated once in two minutes, the workmen carried out the various operations required during the rotation, and in the two minutes twelve castings could be produced. The castings were remarkably accurate, and in this connection he exhibited a sample of a piston produced by this plant, showing that the thickness of the webs was very uniform. The ordinary sand castings could not be produced over and over again with such accuracy as that with which castings could be produced in the permanent moulds. The moulds in the Holley Carburetor Company's plant were made of cast iron, and lined with a refractory material, the thickness of the lining depending to some extent on the amount of metal to be cast. The refractory lining consisted usually of two parts. The first part was a cementing material—a clay substance which was adherent to the iron. On top of that there were a series of layers of refractory material, each one being dried and fritted by heat, to give the lining of the mould the properties of a brick. The porosity of the lining must be very small indeed, in order to avoid the production of tentacles or fibres of metal, which would tend to pull the mould to pieces. A coarse refractory lining would have a very short life. The refractory lining alone, however, was not sufficient to give the rate of cooling which was desirable in order to retain the properties of the cast iron and prevent the production of a superficial white iron, so that, just before pouring, the lining was coated with a very thick layer of carbon,* deposited by an acetylene flame. No gases must be evolved when the metal came into contact with the mould. Obviously, the thickness of the lining had a bearing on the rate of cooling. One would expect to have to choose carefully the iron used, in order to avoid chilling or crystallisation, but, as a matter of fact, many classes of irons had been used with perfectly satisfactory results. The irons of America, however, were usually softer than those used in this country, and as a rule there was a preference for high-silicon irons. The iron which gave the best results contained from 2.5 to 3.5 per cent. of silicon. On the whole the cast iron used was not very different from the ordinary cast iron of the foundry, and no particular pains seemed to be taken to obtain a superior metal.

Properties of the Metal.

Examination of the material after casting showed that it was cast much better in these permanent moulds than in sand moulds. For instance, although the hardness was about the same, the tensile strength was increased from 8.9 to 12.0 tons per sq. in., and the compressive strength from 23.6 to 31.7 tons per sq. in. The metal was close-grained, had a much finer structure than that cast in sand moulds, and was free from blowholes.

The parts of the moulds were held tightly together by toggle joints. The moulds were filled while the table on which they were fitted rotated. In the course of its travel, the moulds were opened, and pins were provided for ejecting the castings automatically. As soon as the casting was ejected from any mould, a blast of compressed air was blown into the opening of the mould in order to clean it thoroughly. The surface of the mould was then smoked heavily by means of the acetylene flame, the dried cores were inserted, the mould closed, and again filled with molten metal, the operations being then repeated. Every morning the moulds were inspected, and any defects of the surfaces were made good. The refractory might be made of any ordinary material used as a refractory, such as ordinary fireclay, but silicate of soda and potash were used to a large extent as a binding material.

The moulds were rather expensive in first cost. When it was realised, however, that each mould had turned out something like 20,000 castings, and, he believed, none of them had yet been replaced, it would be appreciated that the cost of the mould per casting was negligible. Under normal circumstances small castings were poured and ejected from the mould in about ten seconds. The rate of working was such that the head was very often still molten when the casting was ejected.

The uniformity of the castings, their freedom from porosity, and soundness, made it possible to use this material in cases where the use of brass was formerly considered necessary, thus effecting considerable economy. The cost of carburettor castings had been reduced by about 70 per cent. as compared with the cost before this process was put into operation. When heavy castings were produced, the process was necessarily slower; the table must rotate more slowly, and a blast of air might be necessary for cooling the moulds. Normally, casting took place in a mould at a temperature of about 400 deg. C. One man could readily pour 400 small castings per hour. At the Holley Carburetor Company's works there were eight

* We understand from other sources that this is not the case, the layer being only of infinitesimal thickness.—EDITOR.

machines in use, having a capacity of 40 tons per eight-hour day. The floor space occupied by the machines was 2,700 sq. ft.

DISCUSSION.

Lowered Machining Allowances.

Mr. F. A. Greene, referring to the manner in which the castings were knocked out of the moulds, asked how many of the castings were smashed as the result.

Professor Hinchley prefaced his reply by stating that he could not answer questions at first hand, because he had not seen the actual plant. At the same time, there were gentlemen with whom he had been acquainted for many years, who were intimately connected with it, and with whom he had had long conversations with regard to their experience. Replying to Mr. Greene's question, he said that the castings during the early part of the cooling period were very strong, though later they became very brittle, and the number of wasters was almost negligible as compared with ordinary practice.

Mr. Greene asked what thickness of metal was taken off piston castings by machining.

Professor Hinchley said he had been impressed by the fact that the Holley Company worked to much finer machining limits with this type of casting than with sand castings. The machining allowance in the case of these pistons was extremely small, about $\frac{1}{8}$ in., which compared with something like 3-16th in. in the ordinary way.

Cooling-up Conditions.

Captain C. J. Goodwin, referring to the fireclay linings of the moulds and the coatings of acetylene carbon, asked if the cores used were made of material similar to that of the linings, whether they were coated with carbon, and whether they were kept as hot as the moulds themselves. He also asked what experiments had been made with regard to the quality of the cast iron. It appeared from Professor Hinchley's remarks that they did not bother much about that, and that the success achieved was due to the moulds. Most people would agree, however, that there was a great deal in the metallurgical methods employed, as distinct from the foundry methods.

Transporting Metal to the Moulds.

Mr. S. J. Tungay said he was convinced that special care had to be taken in the selection of the quality of iron used for the reproduction of castings of this character, because if one chose too hard an iron, or one which would shrink considerably when cooling, a considerable number of wasters would be produced by these methods. Rapid casting methods, even on rotating tables, were not altogether new in this country so far as brass, aluminium and non-ferrous alloys were concerned. He had been surprised to notice that in such a modern American factory as that of the Holley Company the metal was brought to the moulds by hand pouring from ladles rather than automatically. In centrifugal pipe and piston ring casting methods which he had watched in this country, the molten metal was conveyed to the moulds from the furnaces by gutters, there being also an arrangement for stopping the flow of metal at any particular time, instead of the moulds being filled by hand ladles, and the machines being stopped when the supply of molten iron was not forthcoming. Doubtless there was a fair number of scrap castings produced by the Holley Company; that must be expected, on account of the rapidity with which the castings were produced, but, inasmuch as they were produced so very cheaply, probably, in the aggregate, the wasters represented a more or less negligible quantity.

First-hand Experiences Described.

Mr. J. E. Fletcher (Dudley), who has seen the plant at work, and has had considerable experience of the products of the Holley Carburettor Company, said that Professor Hinchley was right in saying that metal which was rich in silicon had to be used in this plant, in order to avoid the extra contraction which would occur if the silicon content were low. The composition of the metal was not quite such a simple matter as Professor Hinchley would have them believe, and a great deal of time had been devoted to experiment before the Holley Company had arrived at the exact composition of the metal to be used. In the production of the Fordson manifold castings the Holley Company were dealing with a very difficult problem. The production of such castings was a difficult problem in any foundry, even using green sand moulds, and when he was at Detroit he had seen the first experiments being made on those castings. He would not like to say how many failures there had been before success was achieved—he had not been told how many—but, when one considered that these castings were made in thousands, if one achieved success after producing a few hundreds of wasters those wasters did not count. Any foundryman would know that it was an impossibility to produce such a casting as a manifold correctly the first time, or the hundredth time, almost. Automobile foundries to-day found it very difficult to produce those castings sound, but there was no doubt that the use of the permanent mould did improve the position very greatly.

Type of Metal Used.

If the same metal as was used in permanent moulds were run into sand moulds, the result would be very poor. The metal which the Holley Company used for these castings was not metal which we in this country would call high class, and if it were not for the fact that it was poured into metal moulds and cooled quickly, the castings would be unsound and coarse-grained. To see the plant in operation was an inspiration. He had seen such a plant also in the Ford works, where they were making many thousands of castings per day. The metal was not looked upon as being of the very highest grade, but it was quite good enough for the purpose, and the castings stood up to the pressures imposed upon them. It would be very difficult to produce the castings in ordinary green sand or dry sand moulds to withstand the pressures used in the carburettor, but those produced at Detroit were tested and, almost without exception, were found to be sound.

Castings are Annealed.

The castings, however, when they fell out of the moulds, were not quite ready for machining; they had to be annealed, but the annealing furnace had not been shown on the film. The annealing, of course, added to the cost of the castings, but it had been found necessary, as was the case in practically all these light permanent mould processes, to anneal the castings, for fear there should be slight hardness at certain portions of the surfaces; any metallurgist would understand that it was necessary in the case of castings which, in some cases, were only $\frac{1}{8}$ in. thick. The Holley Company had sent him one of their latest castings—which was a pan of about 1 ft. diameter, less than $\frac{1}{4}$-in. thick, with a branch on one side, and a flange—the whole casting was definitely sound, and he considered it a wonderful piece of work. The analysis revealed the fact that the silicon content of the metal had to be particularly high, in order that the metal should not chill or contract too suddenly when in the mould.

Elimination of Refractory Lining Suggested.

Mr. V. C. Faulkner (President of the Institute of British Foundrymen), after thanking the Chemical Engineering Group for having extended to him an invitation to be present, suggested that the Holley Company's process might be applied with advantage in this country to the making of railway chairs, because that was a definite mass-production job, and would eat up metal more quickly than anything in the automobile industry. It might be taken for granted that this process was one based on the thermal history of cast iron, nothing more and nothing less, and the Holley Carburetor Company had been successful in arranging cooling conditions so that their production was definitely a grey iron having suitable properties. He was not convinced that a refractory lining was necessary, however, and it was conceivable that a method could be evolved whereby similar castings could be made without refractory linings being used, and the moulds would arrive at a stable thermal condition after the manufacture of, say, 10 or 20 castings per mould. These first 10 or 20 castings would be white, and could be scrapped, and for the rest of the day the moulds would turn out normal castings. That process was being worked in

Great Britain for the production of centrifugal castings. All castings made during the first ten minutes or so each morning were scrapped; after that period equilibrium was reached and normal production was established. The problem of filling the moulds might easily be solved by the installation of a runway with the ladles attached to it, and pouring always in the same position. He asked also what was the limit to the size of casting that could be produced by this process, and said he was inclined to think that even a railway chair might be too heavy for it; at any rate, a railway chair would represent just about the limit on account of the serious contraction difficulties to be overcome. There was a process, of German origin, which was at work in Derby, used for the making of special pipe bends for chemical and other plant. The body of the mould was made of a permanent or semi-permanent material, but the ends, which contained the flange, were made of ordinary sand, and re-made for each mould in order to take care of the contraction. Finally, Mr. Faulkner congratulated the Holley Carburetor Company on having found these definitely stabilised conditions which were capable of producing a good grey machinable iron under very economic conditions.

C.I. Shell Manufacture Described.

MR. A. H. MUNDEY (Chairman of the London Local Section of the Institute of Metals) recalled the fact that at Woolwich a good many years ago —certainly 20—it was the custom to make shells for practice purposes in cast iron, and in cast-iron moulds. These moulds were thin walled, and the process seemed to be to some extent the precursor of the Holley Company's process. The walls of the moulds were heated almost to red heat, the moulds were fixed up on trunnions, and the number of operators required was very small —he believed about three. The men poured the cast iron into the moulds from a ladle, and a lad worked the tripper, turned the mould over, and turned out the shell. The use of the process resulted in the saving of much money which was previously expended in making sand moulds. The secret of success was regarded as being in the composition, the iron having a very high silicon content. With regard to cores, he asked whether they were destroyed in all cases at the Holley Company's factory. Foundrymen were accustomed now to doing almost the impossible, to screwing cores out of castings made of the lower-melting-point alloys and producing female threads of quite fine character, and he asked whether it was possible for the Holley Company in some cases to make permanent cores of special steels, such as cobalt-chrome or some of the special chrome steels, and so effect further economies.

Contraction as Limiting Factor.

MR. G. J. WARD (Stanton) asked how much time was required for the preparation of the moulds. It seemed to him that in moulds such as those used by the Holley Company, which were split, so that the two halves could be separated and the castings withdrawn, there must be considerable wear and tear on the edges of the moulds. He also asked how much time was required for the repair of the linings of the moulds. The castings produced were comparatively small, and he asked what was the size of the largest casting produced by the process, because there was an enormous future for any process of this kind which could deal with really heavy castings. Another question had reference to the resistance to abrasion of these materials. In many cases, he said, it would be necessary to withdraw the castings from the mould. In the case of pipes, for instance, the contraction was considerable, and was quite sufficient to allow the pipes to be withdrawn, if the moulds would stand such an action. With regard to the strength of castings, he said the castings seemed to be turned out by the Holley Carburetor Company's plant at a very high temperature, and probably the loss through breakage was considerable. Some experiments with which he had been concerned seemed to show that the strength of cast iron actually increased up to a temperature somewhere about 550 deg. C., but after that point it appeared to drop off very rapidly. He imagined that the temperature at which the castings were turned out by the Holley Company's plant was considerably higher than 550 deg. C., and, if that were so, it would be found that the strength of the iron was rapidly dropping off at that stage. Discussing sulphur, and the composition of the metal, he said that the American irons contained fairly high percentages of manganese, and the chances were that, if a reasonably good coke were used, the sulphur should not give trouble, because of the presence of the manganese. He presumed that there was no gas or moisture, or anything of that nature, coming off from the castings, so that there would be no need for vents. With regard to the coating of carbon which was deposited on the mould by the acetylene flame, he asked what its thickness was, and whether that carbon, being in a more or less nascent state, was readily absorbed by the iron on the face of the casting, and whether that would assist in preventing a chill on the metal. Finally, he said that if the castings had to be annealed, that would seem to reduce the value of the process considerably, because annealing—on bigger castings, at any rate—was a very serious matter. If it could be eliminated by the use of a rather thicker refractory, it seemed that that would make an enormous difference to the cost of making heavier castings.

Properties of Cores Used.

MR. LACK asked if the cores used by the Holley Company in the permanent moulds were made in any special way, because the cinematograph film had shown the cores being handled in a manner which cores as he knew them would not stand very well. One of the most remarkable points about a piston casting made by the Holley Company, and exhibited by Prof. Hinchley, was the extremely beautiful interior surface, and that would be due entirely to the core.

Possible Economies.

MR. E. W. WIGG suggested that, apart from the making of automobile parts and such things as railway chairs, plant such as that of the Holley Company would have very little application in foundry practice, in view of the performance of fairly up-to-date moulding machines. Moulding machines could turn out fairly large quantities of castings cheaply, if properly used. They could turn out large quantities at, say, £12 per ton, which represented something like a saving of 70 per cent., although if one had to buy pig-iron at £4 10s. or £5 per ton, as was the case in the South of England—it was cheaper in the North—it did not leave much room to save 70 per cent. With regard to the thickness of the refractory lining of the mould, he said that if there were excessive heating of cast iron one would get broken castings. This might cause deformation of moulds, at any rate if one had a fairly thin lining and a fairly heavy section of metal, and that raised the whole question of the maximum thickness of metal which could be cast in these moulds. He asked whether the pressure of the air blast for cleaning the moulds was 80 or 100 lbs. per sq. in.

PROFESSOR HINCHLEY said he believed it was 200 lbs. per sq. in.

Nature of Metal Used.

PROFESSOR HINCHLEY, referring to the cores used in the moulds, said they were bone dry, and were made of a special composition. Each core was wasted after the casting was made; the Americans had studied the core question carefully, and had concluded that it would be more costly to provide permanent cores than to waste them, on the same principle that the moulding machine would beat this machine for the making of simple castings. As to the statements that plant on these lines had been used before, he said that as time went on it would be almost impossible for anybody to do anything which somebody else had not attempted before, but the fact that the Holley Company were making money by the use of this plant was far more important than the fact that Tom, Dick or Harry had done something like it in the past but had not made money. He would give the Holley Company the credit for having done something which others had failed to do in the past. He agreed with Mr. Fletcher that the Company had made many experiments in connection with the composition of the iron used, and

a normal analysis was: T.C., 3.5; Si, 2.55; P, 0.285; S, 0.085; and Mn, 0.065 per cent. The silicon content was sometimes more than 2.55 per cent. He believed, but was not sure, that the metal was the same as was used in the sand-casting plant, but it would not give the quality of iron that would serve for carburettors and similar castings; it was almost impossible to avoid porosity and other faults. Referring to the remarks made as to the crude method of pouring adopted by the Holley Company, he said it must be remembered that all new processes passed through a period of evolution. It was quite possible that the use of gutters for pouring the metal would be advantageous, but it was also possible that the pouring had to be done by a man with a certain amount of skill, who would have to watch carefully what was happening to the metal in the ladle, and it was quite possible that, just as a wheel-barrow was more efficient than a conveyor for some purposes, a hand ladle was just as efficient for the pouring of small castings as a more elaborate device would be. There was a tendency for people to adopt elaborate methods because they thought such methods would effect savings but often they did not effect savings. A man could cast 400 castings per hour with a hand ladle in the Holley Company's plant; whether or not a man could cast 420 if a gutter system were installed and obtain the same proportion of good castings he (Professor Hinchley) did not know. The suggestion was that hand pouring was slow, but he did not think it was, at any rate for the small castings, although for larger castings it would probably be slow. To-day castings were being made which were larger than those made when the film was produced, and a railway chair was certainly not the largest casting that could be made in this plant. He believed the largest casting made so far was something like 40 lbs. The temperature of the small castings when ejected from the moulds was of the order of 600 deg. C., which was just about the recalescence point, or just below it. The thickness of the refractory material must be greater for small castings than for large castings. Commenting on Mr. Fletcher's statement that the castings had to be annealed, he said that quite a number of them were annealed, but he had understood—although he would not be emphatic about it—that a large proportion of the small castings were not annealed beyond the natural annealing they received when they fell out of the moulds and lay together on the floor for some time in a very hot condition.

MR. FLETCHER said that probably the use of the term "annealing" might have created a wrong impression, but the castings went into a furnace, in which they were held at a certain temperature for a certain time. It was not strictly annealing, as in the case of steel.

Heat-treatment Details.

PROFESSOR HINCHLEY said that these castings were raised to a temperature of 800 deg. C. for a period of a quarter of an hour, and then, over a period of 70 minutes, they cooled down to 318 deg. C. Replying to Mr. Ward's question as to the time necessary for the repair of the moulds, he said that generally every morning each machine was attended to for about half an hour, and the refractory material was carefully made up in places where it had suffered from abrasion. The refractory material on the surface of the mould was as hard as a hard brick, but it did suffer to some extent through the falling of the castings. The coating of carbon* was very thick, and the whole of the carbon appeared to be absorbed by the iron; that was probably responsible to some extent for the good superficial condition of the castings, and he was rather inclined to think that that feature of the mould was one of the most valuable ones. The fact that the internal surfaces of the castings were extremely good, as had been pointed out by Mr. Lack, was due to the fact that careful study had been given to the question of the cores. There was some very fine branding on the inside of some of the castings; in every piston there were letters $\frac{1}{8}$ in. or $\frac{1}{4}$ in. high, giving the whole story with reference to that particular article. With regard to Mr. Wigg's remark, that apart from the making of small automobile parts and railway chairs, a plant such as that used by the Holley Company would find little application in the foundry, and that the moulding machine was capable of doing all that was necessary, he said it was as well to keep an open mind on the subject. The problem was capable of being worked out on paper in terms of £ s. d., and he certainly did not think the moulding machine would touch a plant of this kind. The 70 per cent. saving he had mentioned was a saving of 70 per cent. on the previous practice of the Holley Company. For instance, a carburettor body made by the best methods they could find previously had cost 25 cents, whereas the cost, when made by the machine described, was 7 cents. There was one very satisfactory thing he would like to emphasise, namely, that one could not turn out cheap things without making them good, and the better the article the cheaper could it be made. The secret of quantity production to-day was not that of rushing the material through, but of making the best that could be made, and he knew of no industry in which that did not hold. With regard to the runners and risers referred to by the Chairman, he said it was true that piping had to be avoided, and this particular metal, if cast in sand, would pipe very badly indeed. He did not consider that the runners and risers used were extraordinarily heavy for the size of casting dealt with.

* See earlier footnote.

Institute of British Foundrymen.

Birmingham, Coventry and West Midlands Branch.

At the annual meeting of the Branch, reported in our columns last week, the following officers were appointed: *President*, Mr. F. G. Starr; *Vice-Presidents*, Mr. E. H. Tyson and Mr. D. Wilkinson; *Hon. Secretary*, Mr. F. K. Neath; *Hon. Treasurer*, Mr. G. E. Dicks; *Members of Council*, Messrs. F. C. Edwards, Turner, Curnow, and Westwood; *Delegates to serve on the General Council*, Messrs. J. B. Johnson, F. C. Edwards, D. H. Wood, and E. H. Tyson.

THE PRESIDENT announced that the Council had decided that during the ensuing session six of the meetings should be held on Thursday evenings and the remaining two on Saturday evenings. The annual outing would take place on June 25, the destination being Malvern.

Mr. Wood was heartily thanked for his able and enthusiastic service during the two years he has occupied the Presidential chair.

MR. WOOD briefly acknowledged the compliment, and handed to Mr. Neath a memento of his association with him in the work of the Branch.

A New Type of Moulding Machine.

The Universal System of Machine Moulding and Machinery Company, Limited, Queen Victoria Street, E.C., have developed a new type of moulding machine, the A.F. type, which is being built in 10 sizes, the first two having recently been delivered. These machines also employ the firm's well-known down sand frame, whereby, it is claimed, production is increased by at least 20 per cent. Of particular interest is the new-type machine in connection with flat shallow work. By the use of the down sand frame, the pattern is pressed into the mould instead of the mould on to the pattern, making it possible for the bars to act as the ramming plate, this being the main point on shallow work. It is stated that by this means a shallow mould has been rammed and the mould withdrawn in 1½ seconds.

Empire Industries Association.—This Association for the extension of Empire preference and transport and the safeguarding of home industries (26, Abingdon Street, Westminster, S.W.1), has been formed for the purpose of educating public opinion on the policy of Imperial preference and safeguarding of industries. It now issues a weekly news service, prepared by Mr. H. G. Williams, M.P., dealing with the subject. The policy and programme of the Association is fully explained in a pamphlet specially issued for the purpose.

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SULPHUR	„ „	0.8%
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Trade Talk.

The Wolverhampton Corrugated Iron Company, Limited, have installed two new sheet mills, making a total of 24 at these works.

The style of the National Association of Supervising Electricians has been altered to the Association of Supervising Electrical Engineers.

The Leeds Forge Company, Limited, are not now working their open-hearth steel plant, which comprised four 30-ton and one 20-ton furnaces.

The Yorkshire Refractory Materials' Association has been closed down. The secretary was Mr. H. Stead, Dale Street N., Claremont, Halifax.

The Halifax and District Master Ironfounders' Association, of which Mr. F. S. Mitchell, 8, Ward's End, Halifax, was secretary, is now defunct.

The Etna Iron and Steel Company, Limited, Etna Iron and Steel Works, Motherwell, have removed their London office to 82-83, Fenchurch Street, London, E.C.3.

The Rugby and District Allied Engineering Trades' Federation, of which Mr. P. S. Allison, 54, Claremont Road, Rugby, was secretary, no longer exists.

Robert Heath & Low Moor, Limited, Low Moor Iron Works, Bradford, Yorks, have now only eight puddling furnaces at their works against ten a short time back.

Smith & McLean, Limited, have discontinued the ten puddling furnaces at their Milnwood Works. At Gartcosh and Mossend the firm have installed an additional sheet mill, making eleven in all.

Thos. W. Ward, Limited, of Sheffield, have acquired a large sugar refinery at Rawcliffe Bridge, near Goole, owned by Macfie & Sons, which has been out of commission for a number of years.

A petition of the Institution of Structural Engineers, seeking a Charter of Incorporation, has been referred to a Committee of the Lords of the Council. Objections should be delivered at the Privy Council Office by May 26 next.

The Leeds and District Engineering and Allied Trades' Joint Committee, and the National Engineering and Allied Trades' Joint Committee, of which Mr. L. Magson, 21, Sunfield, Stanningley, Leeds, was secretary, have ceased to function.

The puddling furnaces at the works of the Harts Hill Iron Company, Limited, Brierley Hill, have been reduced to 18 from 20 formerly in operation, and the 9-in. bar mill has been replaced by a 10-in. There is also a 20-in. bar mill at these works.

The Electric Furnace Company, Limited, of 17, Victoria Street, London, S.W.1, have received orders for six Ajax-Wyatt brass melting furnaces, each of 600 lb. capacity, for a French firm, and also a 100-kilowatt resistance furnace for annealing aluminium sheet in Scotland.

The General Refractories Company, Limited, Kelham Island Firebrick Works, Sheffield, announce that their Newcastle agents, Parson & Colls, Limited, have moved their offices from 30/32, Side, Newcastle-on-Tyne, to Clarendon House, Clayton Street West, Newcastle-on-Tyne.

Alfred Herbert, Limited, Coventry, announce that their "A. H." monogram, which they have used on their products and in their publicity matter for a number of years, is now registered as a trade-mark. It will be remembered that the design comprises the letters A. H. contained in an oval.

Intimation has been made to Mr. J. C. Bishop and Mr. O. Coyle, joint secretaries of the Board of Conciliation for the Regulation of Wages in the Pig-iron Trade of Scotland, to the effect that, after examination of the employers' books for January, February and March last, the average net selling price has been certified to be £4 5s. 1d. This means that there will be a decrease of 6 per cent. on basis rates in the wages of the workmen.

A considerable improvement in the relationship between employer and employed is confidently expected as the outcome of a conference of the Manchester Engineering Council, held in Manchester University. The speakers included Mr. W. M. Citrine, secretary of the Trades Union Congress; Mr. J. T. Brownlie, president of the A.E.U.; Mr. T. Rowan, secretary of the Electrical Trades Union; Mr. S. Ratcliffe, A.E.U.; Mr. T. Chadwick, Moulders' Union, for the operatives. Prominent employers were Mr. W. L. Hichens, of Cammell, Laird & Company, Mr. A. Ramsey, Birmingham Engineering Employers' Association; and Mr. C. G. Renold, of Hans Renold, Limited. Summing up at the conclusion of the conference, Mr. L. E. Mather (chairman of Mather & Platt, Limited) said the conference had been conducted in a very satisfactory style. He was tremendously impressed, not so much by the number that had attended, but by the quality of the speeches, the pointedness of the discussions, and the practical way in which the whole thing had been treated.

Company Reports.

H. H. Vivian & Company, Limited.—Debenture interest, £1,350; depreciation reserve, £2,000; brought in, £615; debit balance, £3,336, carried forward.

Sanderson Brothers & Newbould, Limited.—Trading loss for year, £11,941; transferred from contingency account, £9,984; debit reduced to £1,957; debenture and other interest, £5,732; total, £7,689; balance from last year, £4,324; debit to profit and loss, £3,365, carried forward.

Johnson & Phillips, Limited. — Profit on trading account, etc., £115,113; brought forward, £92,133; interest on debenture stock, £17,347; reserve for debenture sinking fund, £15,217; income-tax, £2,695; depreciation, £12,644; final dividend, 7½ per cent., less tax, on ordinary shares, making 12½ per cent. for year; carried forward, £82,475.

Personal.

Sir Robert McLean has retired from the position of agent of the Great Indian Peninsular Railway to take up a position with Vickers, Limited.

Wills.

Woolley, E., of Blackburn Road, Accrington, ironfounder	£13,108
Brassington, T., of Coopers Hill House, Coopers Hill, West Bromwich, furnace builder	£23,542
Hempstock, C. A., of Oldham, secretary of Platt Bros. & Company, Limited, engineers and machinists	£25,587
Tickle, R. J., of Douglas Bank House, Wigan, and of Tickle Bros., Limited, Vulcan Foundry, Wigan	£15,059

Obituary.

Colonel R. Howie, of P. & R. Fleming & Company, iron and metal merchants, Glasgow, died April 16.

Mr. Geo. Berwick, works manager at the shipyard of J. P. Rennoldson & Company, South Shields, was found dead in a store room at the works.

The death occurred at Priory Park, Castlehead, Paisley, on April 20, of Mr. William Bow, J.P., late of Bow, M'Lachlan & Company, Limited, engineers and shipbuilders.

The death took place last week at his home in Jesson Road, Walsall, of Mr. John Thomas Guest, who for many years had carried on in the Wolverhampton Road one of the oldest malleable iron founding businesses in the town, it having been established by his father.

The death occurred on Monday, at the age of 51, of Mr. F. Knighton, Handley Wood, Barrow Hill, manager of the Staveley Coal & Iron Company's new works and blast furnaces. He had been in the employ of the company since he left school, and he had been blast-furnace manager for 19 years.

Mr. W. Bagshaw, a well-known Yorkshire engineer, died at Harrogate on April 26, aged 75. He was born at Dewsbury, and lived most of his life at Batley, where he held a prominent position in business, educational and civic affairs. After education at the Batley Grammar School, the Wesley College, Sheffield, and the Yorkshire College (now Leeds University), he joined his father in the engineering business of J. Bagshaw & Sons, Victoria Foundry, became a partner in 1878, and chairman of directors in 1891. He retired in 1907, but continued his various public interests with great activity.

New Companies.

Compressor and Pneumatic Tool Hire Company, Limited.—Capital £100 in £1 shares. Directors: Lt.-Col. G. J. Selwyn Scovell, Ashmansworth Manor, Newbury; Sir Grograve C. Beauchamp, Bt., 4, Deanery Street, W.; and G. H. Wilson-Fox, 9, Chester Street, S.W.1.

Dawkins Light Castings, Limited, Highfields, Bilston. —Capital £14,000 in £1 shares. Directors: W. A. Dawkins and Mrs. E. M. Dawkins.

Dolomite Bricks, Limited, Ambergate, near Derby.— Capital £100 in £1 shares. Directors: E. Glossop, Ambergate, near Derby; J. Hodson, Hackney, Matlock, Derbyshire; and T. Hodson, Hackney, Matlock, Derbyshire.

A. G. Kidston & Company, Limited, 93, West George Street, Glasgow.—Capital £85,000 in £1 shares. Iron and steel merchants. Directors: W. H. Kidston, J. C. Blair, H. B. Kidston, and P. L. D. Kidston.

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Few signs of improvement can as yet be detected in the general position of the Cleveland iron market, business having been for some time past confined almost entirely to limited transactions to meet urgent immediate requirements. The chief obstacle to progressive development of the iron trade remains, as for a long time past, the excessive cost of fuel; furnace coke is still about 4s. per ton dearer than it was before the coal strike, but it has to be remembered that prior to that event it was being produced with subsidised coal. Substantial reductions have been made in the price of coke during recent months, but more will have to be effected before there can be any real recovery in pig-iron. Meanwhile, prices have been reduced 5s. from last week's levels. No. 1 is quoted at 77s. 6d., No. 3 G.M.B. 75s., No. 4 foundry 74s., and No. 4 forge 73s. 6d. per ton.

The Tees-side hematite market continues quiet, and quotations show an irregular tendency, but East Coast mixed numbers can be done without difficulty at 82s. per ton. No. 1 is offering at 6d. per ton more. On the North-West Coast Bessemer mixed numbers are quoted at £4 14s. 6d. per ton, delivered at Glasgow, £4 15s. 6d. per ton delivered at Sheffield, and £5 1s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—The only change of note in the local markets for foundry pig has been a slightly easier tendency in prices of Derbyshire No. 3 quality, for which makers are now quoting from 80s. 6d. to 81s. per ton, on rails at the furnaces, or equivalent to 88s. 6d. to 89s. delivered in the Manchester district. Scottish brands of foundry iron are still on offer here at a minimum of about 102s. per ton delivered.

THE MIDLANDS.—Ironmasters supplying this area find that founders cannot be induced to enter the market for quantities whilst prices are round their present levels. At the present moment Derbyshire No. 3 is offered freely at 80s. per ton, f.o.t., and no doubt North Staffordshire furnaces will be prepared to take a similar figure. Northants No. 3 is at 77s. 6d. per ton, f.o.t. furnaces, while small parcels of Scotch qualities are available at 105s. to 107s. 6d. per ton delivered locally.

SCOTLAND.—Forward business in Scotch iron is practically at a standstill, and the price will have to be materially reduced before any improvement takes place in this respect. No. 3 Scotch foundry is 84s. at furnaces, No. 3 Continental foundry being quoted to-day at 74s. 6d. at Grahamston.

Finished Iron.

At Birmingham this week the market for all classes of finished material continues poor in the extreme. The demand for iron, apart from marked bars and other special qualities, is negligible, and makers cannot secure sufficient business to keep going regularly. The marked bar price is unchanged at £14 10s. per ton at makers' works. There is no quotation below £11 per ton for crown iron, and makers from this and other areas are very anxious indeed to secure what small volume of business there is available. The Continental price for No. 3 iron is still weak, and £5 17s. 6d. per ton delivered here is being quoted freely. Nut and bolt iron from Staffordshire works is £10, and very few orders are maturing in consequence of the Belgian competition.

Steel.

In the steel market there is a trifle more business moving, and makers of acid billets report an improved demand. Basic qualities remain very much as for a month past, and nowhere is there any change in prices. There is a big output of open-hearth steel, and the production of crucible steel is on a rather larger scale. The demand for Sheffield's special steels is reviving, and some substantial orders are coming to hand both from home and oversea sources.

Scrap.

Inactivity continues the rule in the markets for scrap metal, with prices everywhere inclined to an easier tendency. In Scotland cast-iron borings are quoted 47s. 6d. per ton, and for clean, heavy turnings 50s. to 51s. 3d. per ton. Heavy machinery cast-iron scrap is still easy around 78s. 6d. to 80s. per ton, for material suitable for foundries, and in pieces not exceeding 1 cwt. Heavy ordinary cast-iron scrap to the same specification is 5s. per ton less, and for steel works material, in furnace sizes, 71s. 3d. per ton. Light cast-iron scrap and firebars are unchanged at 57s. 6d. to 58s. 6d. per ton. The above prices are all per ton, delivered, f.o.t. consumers' works.

Metals.

Copper.—Movements in standard copper have again developed a lower tendency in values, with business on consumers' account in somewhat diminished volume. The outlook, however, is regarded as fairly satisfactory, and, assuming that moderate supplies are still needed to complete requirements over the spring, the market is capable of further improvement. The view is held by a prominent merchant firm that things would have righted themselves a good while back if the market for electrolytic had not been artificially held under Combine control.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £54 13s. 9d. to £54 15s.; Friday, £54 11s. 3d. to £54 12s. 6d.; Monday, £54 11s. 3d. to £54 12s. 6d.; Tuesday, £54 7s. 6d. to £54 8s. 9d.; Wednesday, £54 8s. 9d. to £54 10s.

Three Months : Thursday, £55 5s. to £55 6s. 3d.; Friday, £55 1s. 3d. to £55 2s. 6d.; Monday, £55 1s. 3d. to £55 2s. 6d.; Tuesday, £55 to £55 1s. 3d.; Wednesday, £55 1s. 3d. to £55 2s. 6d.

Tin.—Equally disappointing is the position of standard tin, in which there has been a sharp reaction, and the market has been most depressing, values falling to the lowest recorded over three months. Spot supplies of the metal a couple of months ago were very small, but since then there has been an appreciable change, and the statistical position has had a very considerable influence on price movements, combined with an absence of supporting orders. Really it looks as though the market has met for the time being with a determined "bear" raid.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £295 10s. to £295 12s. 6d.; Friday, £294 to £294 5s.; Monday, £298 15s. to £299; Tuesday, £297 to £297 5s.; Wednesday, £296 5s. to £296 10s.

Three Months : Thursday, £290 to £290 5s.; Friday, £287 10s. to £287 12s. 6d.; Monday, £289 17s. 6d. to £290 2s. 6d.; Tuesday, £288 15s. to £289; Wednesday, £288 to £288 5s.

Spelter.—Fluctuations in values of ordinary spelter have been comparatively small, but there has been a slight tendency to ease. This has been partly due to American uncertainties, while there has evidently been an accumulation of stocks on the other side. The demand on this side has remained quiet, and Continental buying has been generally restricted.

The following are the week's prices :—

Ordinary : Thursday, £29 6s. 3d.; Friday, £29 2s. 6d.; Monday, £29 7s. 6d.; Tuesday, £29 2s 6d.; Wednesday, £29 3s. 9d.

Lead.—There is plenty of soft foreign pig available, which, together with the weakness shown in America, has induced a decline in values. With the continued plentiful arrivals, what demand there has been from consumers has been freely met, although such demand has been heavier at times than was anticipated.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £25 15s.; Friday, £25 11s. 3d.; Monday, £25 18s. 9d.; Tuesday, £25 15s.; Wednesday, £25 13s. 9d.

The Wilford Malleable-Steel Casting Company, Limited, are being voluntarily wound up. Mr. A. E. Lacon, 14, Lichfield Street, Wolverhampton, has been appointed liquidator.

The British Aluminium Company, Limited, Adelaide House, King William Street, E.C., point out that American reports are to the effect that several railways in the country have constructed trains employing aluminium extensively, 'bus makers are expanding rapidly, and the general automotive trade is swinging back to aluminium and its light alloys on a scale unsuspected by the uninformed observer. The aircraft industry, destined to become one of the chief outlets for aluminium, is probably operating at a heavier rate to-day than at any time since the war, with encouraging prospects for still greater activity in the near future. In the high-voltage transmission field aluminium is established.